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A REVIEW OF THE STATUS REPORT ON THE METAL MINING SECTOR EFFLUENT MONITORING DATA

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**A REVIEW OF THE STATUS REPORT
ON THE METAL MINING SECTOR EFFLUENT MONITORING DATA**

by

P. Riveros and D. Koren

ABSTRACT

The authors have reviewed the Status Report on the Metal Mining Sector Effluent Monitoring Data prepared by the Ontario Ministry of the Environment. The status report presents chemical analyses and biotoxicity tests obtained during a one-year monitoring campaign that was carried out on the effluents of all the major metal producers of Ontario. The authors have analyzed and processed the experimental data with the purpose of identifying the major environmental problems and, therefore, some potential business opportunities for CANMET/MSL/EL.

Keywords: Effluents, biotoxicity.

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INTRODUCTION

The municipal and industrial strategy for abatement (MISA) is a regulatory program aimed at the virtual elimination of persistent toxic contaminants from all discharges into Ontario's waterways.

This goal will be achieved by:

1. Identifying and measuring the discharge of toxic substances and conventional contaminants in order to build up a comprehensive database on contaminant discharges across Ontario.
2. Increasing the emphasis on control technology through the application of Best Available Technology Economically Achievable (BATEA) to obtain greater reductions of pollution at source.

In the first phase of the program, the metal mining industry was required to monitor their point source effluents at regular intervals according to specific sampling, analytical, quality control and quality assurance protocols and procedures. Table 1 presents a list of the sampling sites that were included in the campaign (it should be pointed out some metallurgical plants had more than one sampling point). The site list is divided into the following sectors: base metals (17 sampling sites), gold (21 sampling sites), iron (1 sampling site) and uranium (12 sampling sites). Monitoring began on February 1, 1990 and was completed on January 31, 1991. Following this 12-month monitoring period, the industry was required to report to the Ontario Ministry of the Environment the results of all flow measurements and/or estimations and all chemical analyses. With these data, the Status Report on the Metal Mining Sector Effluent Monitoring Data was prepared. During the monitoring period the Ontario metal mining industry processed approximately 100,000 tonnes of ore per day and discharged approximately 695,000 cubic meters of wastewater per day.

The effluents were initially analyzed for 150 parameters (chemical elements or compounds). Most of these were discarded after it was found that their levels were below the detection limits of the standard analytical methods. On this basis, 42 parameters were chosen for further consideration (these are shown in Table 2).

The database that was obtained in this campaign is considered by the Ontario Ministry of the Environment to accurately represent the general nature of effluents discharged by active properties within the sector for the period February 1, 1990 to January 31, 1991. Sampling took place at all major plants within the sector with the exception of a very small number of plants that were in the process of termination of activities. Plants within the sample group accounted for more than 95% of mine production within the sector. In general, sampling was not carried out at properties that generated an effluent flow of less than 50,000 litres per day.

CHEMICAL ANALYSES

The report presents the chemical composition of the effluents of every major metal producer in Ontario. There are tables on monthly average concentration, daily concentration, annual loadings (discharges), etc.

For the purpose of finding the most serious environmental problems (and business opportunities for CANMET), two objectives were defined:

1. Identification of the parameters (chemical elements or compounds) whose levels are relatively high in a large number of companies. These companies may be willing to participate in a consortium-type project.
2. Identification of the companies whose effluents may have unusually high levels of a given parameter. These companies should be more inclined to spend money on research to avoid problems with the future MISA regulations.

The difficulty with the first objective was to define what can be considered "high levels". For most of the 42 parameters there are no specific limits to the concentrations that may be present in the effluents. As a guideline, Table 3 shows the number of plant effluents whose median concentration was equal to or above the Regulation Method Detection Limit (RMDL). From here, some parameters can be recognized as being relatively rare, e.g., cyanates and most organic compounds. However, since the RMDL values are quite low, the data in Table 3 do not necessarily indicate that there is an environmental problem.

For 14 parameters, a reference level has been defined and this can be considered to be the regulatory concentration limit for mining effluents (although the report does not specifically make this statement). In this case, it was possible to determine the number of sites where the effluent concentrations exceeded the reference levels. These sites have been listed in Table 4 along with a "frequency factor" which indicates how often the samples were over the reference level. The frequency factor ranges from 0 (when none of the samples exceeded the reference level during the monitoring campaign) to 1 (when all the samples were over the reference level). For example, the table shows that nickel in excess of 0.5 ppm was found in 8 sites in the base metals sector and 2 in the gold sector. In the base metals sector, 53.1% of the samples exceeded the reference level, whereas in the gold sector, 40.9% of the samples did the same.

According to this analysis, the most widespread environmental problems are: ammonia, high pH, total suspended solids (TSS), nickel, and copper. Some less common problems, but still important include phenolics, zinc, mercury and molybdenum. Other elements, such as lead and phosphorus, turned out to present no environmental problems.

As an extension of this, Table 5 identifies the sites whose effluents exceeded, consistently or occasionally, the reference levels. The percentage of samples that were over this level is also indicated. From this table the companies with environmental problems can be identified. It was found, for example, that effluents with a high pH (over the limit of 9.5) is a very common occurrence, particularly in the base metal sector. This is most likely the

result of extensive liming treatment with the purpose of precipitating base metals. Some sites, such as Geco, were found to exceed more than one limit (ammonia, pH and copper). Renabie Gold Mines was consistently discharging high levels of zinc (which was not a problem with the other gold mines). Similarly the Cameco refinery at Blind River has a unique problem of high levels of oil and grease. Arsenic is a problem at Arthur W. White Mine (Dickenson). Three gold mines (Eastmaque, Hemlo and Macassa) were found to have high levels of molybdenum. High levels of cyanide was not as common a problem as might be expected, whereas high mercury levels were detected in several sites.

TOXICITY TESTS

A different set of data was obtained from the biotoxicity tests. Until now, the regulatory limits have been set on the basis of what the best available technology can achieve at a reasonable cost. Biotoxicity tests have introduced a new element and there is a concern in industry that in the future the limits may be based, at least in part, on biotoxicity criteria.

In the biotoxicity tests, two organisms, rainbow trout and daphnia magna, are exposed to undiluted effluent and several effluent dilutions for a fixed period. The trout toxicity test is a 96 hour exposure and the daphnia toxicity test is a 48 hour exposure. The number of organisms that die is the toxic effect that is recorded. The quantitative measure of toxicity is the median lethal concentration (LC_{50}) which is the concentration of effluent estimated to cause mortality to 50% of the test organisms.

Table 6 shows a summary of the results. Unlike the chemical analyses, the biotoxicity tests were by no means comprehensive as several sites were not included in the survey. This is because in many cases the tests were not done according to the standard procedure and therefore the results were discarded. Therefore, the sites that are not listed in Table 6, may or may not have lethal effluents.

For the purpose of identifying the sites with potential environmental problems, the biotoxicity tests are very straightforward. However, the problem is that, in general, it is difficult to determine the specific agent that causes the effluent to be toxic to these life forms. Table 6 lists the suspected agents according to the Ontario Ministry of the Environment. The ones most commonly cited are copper, high pH, and ammonia.

CONCLUSIONS

On the basis of the data obtained by the Ontario Ministry of the Environment, it is possible to identify some specific environmental problems along with the companies that are responsible for them. In general, there are no major surprises and CANMET was aware of some of these problems, such as ammonia, suspended solids and copper. On the other hand, this identification exercise was limited to the 14 elements for which a reference level has been defined. For most chemical elements there are no regulatory limits or reference levels and, therefore, it is impossible to determine the degree of importance of the problem.

It is anticipated that MISA will bring about the introduction of limits to all the 42 parameters considered in this study. In the meantime, it may be useful to estimate the average level of every unlimited element from the data. On this basis it would be possible to identify the companies whose effluent are over the average and therefore more likely to face a problem once the regulations come into effect.

According to the report, for every ton of ore that is treated, seven tons of water are discharged to the environment. This seems to be excessive and it can be surmised that companies dilute their effluents as much as possible by deliberately catching run-offs and rain water. This practice, however, does not solve the problem and the Status Report shows that the total discharge of metals and other chemicals is often huge, in spite of having low concentration levels. It also makes the treatment of effluents very difficult.

TABLE 1. LIST OF PROPERTIES

MISA No.	Company, Property, Location	MISA No.	Company, Property, Location
A. BASE METALS SECTOR			
1.	INCO Limited, Copper Cliff Treatment Plant, Sudbury	19.	Dickenson Mines Ltd., Arthur W. White Mine, Golden Township
2.	INCO Limited, Crean Hill Mine, Sudbury	21.	Canamax Resources Inc., Bell Creek Mine, Timmins
3.	Falconbridge Limited, Falconbridge, Sudbury	24.	Teck-Corona Operating Corp., David Bell Mine, Hemlo
4.	INCO Limited, Garson Mine, Sudbury	25.	Placer Dome Inc., Detour Lake Mine, Detour Lake
5.	Noranda Minerals, Geco Division, Manitouwadge	26.	Placer Dome Inc., Dome Mine, Timmins
6.	Falconbridge Limited, Kidd Mine, Kidd Township	27.	Placer Dome Inc., Dona Lake Mine, Pickle Lake
7.	INCO Limited, Levack Mine, Sudbury	28.	Eastmaque Gold Mines Ltd., Eastmaque, Kirkland Lake
8.	Falconbridge Limited, Lockerby, Sudbury	29.	Giant Yellowknife Mines Ltd., ERG Resources, Timmins
9.	Falconbridge Limited, Metallurgical Site, Hoyle Township	30.	Hemlo Gold Mines, Golden Giant Mine, Hemlo
10.	INCO Limited, Nickel Refinery, Sudbury	31.	Canamax Resources Inc., Kremzar Mine, Finan Township
11.	INCO Limited, Nolin Creek Treatment Plant, Sudbury	32.	LAC Minerals Ltd., Macassa Division, Kirkland Lake
12.	Falconbridge Limited, Onaping, Sudbury pond	35.	Canamax Resources Inc., Marhull Mine, Timmins
13.	INCO Limited, Nickel Refinery, Port Colborne	36.	American Barrick Res. Corp., McDermott, Harker Township
14.	INCO Limited, Shebandowan Property, Thunder Bay	37.	Bond Gold Canada, Muskegagagagen Lake, District of Kenora
15.	Falconbridge Limited, Strathcona (Moose Lake), Sudbury	38.	LAC Minerals Ltd., Williams Mine, Hemlo
16.	INCO Limited, Whistle Mine, Sudbury	39.	Giant Yellowknife Mines Ltd., Pamour #1, Timmins
17.	Minnova Inc., Winston Lake Mine, District of Thunder Bay	40.	Giant Yellowknife Mines Ltd., Pamour-Schumacher, Timmins
C. IRON SECTOR			
46.	The Algoma Steel Corp. Ltd., Algoma Ore Div., Wawa	42.	Renabie Gold Mines, Renabie Gold Mines Ltd., Renabie
D. URANIUM SECTOR			
		45.	St. Andrews Gold Fields Ltd., St. A.G.F., Stock Township
51.	Denison Mines Ltd., Denison Property, Elliot Lake		
52.	Rio Algom Ltd., Lacnor/Nordic, Elliot Lake		
53.	Rio Algom Ltd., Panel, Elliot Lake		
54.	Rio Algom Ltd., Pronto, Spragge		
55.	Rio Algom Ltd., Quirke, Elliot Lake		
56.	Cameco, Refinery, Blind River		
57.	Cameco, Refinery, Port Hope		
58.	Rio Algom Ltd., Stanleigh, Elliot Lake		
59.	Denison Mines Ltd., Stanrock Property, Elliot Lake		

TABLE 2. SELECTED PARAMETERS

COD
Total Cyanide
Total Phosphorus
Total Suspended Solids (TSS)
Aluminum
Cadmium
Chromium
Cobalt
Copper
Lead
Molybdenum
Nickel
Zinc
Antimony
Arsenic
Selenium
Mercury
Phenolics
Carbon tetrachloride
Chloroform
Methylene chloride
Benzene
Toluene
m-Xylene and p-Xylene
o-Xylene
2-Methylnaphthalene
Naphthalene
m-Cresol
p-Cresol
Oil and Grease
Ammonia plus ammonium
Total Kjeldahl Nitrogen
Nitrate + Nitrite
Total Organic Carbon
Chlorides
Cyanides, filtered
Dissolved solids
Sulphates
Iron
Thiocyanates, filtered
Uranium
Cyanide (WAD)

TABLE 3: OCCURENCE OF PARAMETERS ABOVE DETECTION LIMITS BY SECTOR.

PARAMETER	DETECTION LIMIT (mg/L)	SECTOR				TOTAL
		Base metals	Gold	Iron	Uranium	
COD	10	14	20	1	7	42
cyanide (T)	0.005	16	20	1	2	39
phosphorus (T)	0.1	4	10	0	0	14
TSS	5	10	14	1	6	31
aluminum	0.03	12	20	1	12	45
cadmium	0.002	17	15	0	2	34
chromium	0.02	3	7	0	0	10
cobalt	0.02	8	11	0	6	25
copper	0.01	12	16	1	5	34
lead	0.03	0	6	0	5	11
molybdenum	0.02	5	13	0	1	19
nickel	0.02	13	15	1	6	35
zinc	0.01	8	14	0	8	30
antimony	0.005	5	11	0	0	16
arsenic	0.005	2	13	0	4	19
selenium	0.005	4	8	1	0	13
mercury	0.0001	8	17	0	1	26
phenolics (4AAP)	2 ug/L	15	9	1	2	27
CCl4	1.3 ug/L	0	0	0	2	2
chloroform	0.7 ug/L	7	5	1	1	14
methylene chloride	1.3 ug/L	0	4	0	1	5
benzene	0.5 ug/L	4	3	1	1	9
toluene	0.5 ug/L	7	3	1	1	12
m-xylene, p-xylene	1.1 ug/L	2	1	1	1	5
o-xylene	0.5 ug/L	6	0	1	1	8
2-methylnaphthalene	2.2 ug/L	1	0	0	0	1
naphthalene	1.6 ug/L	1	1	0	0	2
m-cresol	3.4 ug/L	2	5	0	0	7
p-cresol	3.5 ug/L	2	8	0	12	22
oil/grease	1	15	20	1	5	41
NH3 + NH4	0.25	14	21	1	8	44
total N	0.5	17	20	0	11	48
NO3 + NO2	0.25	16	16	1	11	44
TOC	5	8	15	0	1	24
chlorides	2	17	20	1	12	50
cyanates (filtered)	5	0	1	0	0	1
dissolved solids	20	17	20	1	12	50
sulphates	5	17	20	1	12	50
iron	0.02	17	20	1	12	50
thiocyanates (filtered)	5	10	2	0	0	12
uranium	0.02	0	0	0	11	11
cyanide (WAD)	0.005	16	16	1	1	34

TABLE 4. SELECTED PARAMETERS AND REFERENCE LEVELS.

PARAMETER	REFERENCE LEVEL	S E C T O R S											
		BASE METALS			GOLD			IRON			URANIUM		
		No. of sites	Frequency factor	No. of sites	No. of sites	Frequency factor	No. of sites	No. of sites	Frequency factor	No. of sites	No. of sites	Frequency factor	TOTAL
Nickel	0.5 ppm	8	0.531	2		0.409	0	0	0.000	0	0	0.000	10
Copper	0.3 ppm	5	0.167	8		0.468	0	0	0.000	0	0	0.000	13
Lead	0.2 ppm	0	0.000	0		0.000	0	0	0.000	0	0	0.000	0
Zinc	0.5 ppm	3	0.528	2		0.667	0	0	0.000	0	0	0.000	5
Arsenic	0.5 ppm	0	0.000	2		0.667	0	0	0.000	0	0	0.000	2
Cyanide (T)	1 ppm	1	0.417	3		0.262	0	0	0.000	1	0	0.500	5
TSS	15 ppm	8	0.372	9		0.485	1	1	0.167	5	23	0.417	23
pH	6-9.5	13	0.703	1		0.500	1	1	0.500	1	16	0.167	16
Molybdenum	0.5 ppm	0	0.000	3		0.639	0	0	0.000	0	3	0.000	3
Mercury	1 ppb	0	0.000	6		0.357	1	1	0.167	1	8	0.250	8
NH4 + NH3	10 ppm	2	1.000	9		0.647	0	0	0.000	4	15	0.667	15
Phosphorus	1 ppm	0	0.000	0		0.000	0	0	0.000	0	0	0.000	0
Phenolics	20 ppb	6	0.198	5		0.445	0	0	0.000	1	12	0.111	12
Oil/grease	15 ppm	0	0.000	1		0.083	0	0	0.000	1	2	1.000	2
Frequency factor: 0 = 0% of samples over the reference level. 1 = 100% of samples over the reference level.													

TABLE 5. SITES REPORTING LEVELS ABOVE REFERENCE FOR SELECTED PARAMETERS

PARAMETER (reference level)	Site No.	METAL PRODUCER	Percent of Samples over Reference lev.
NICKEL (0.5 ppm)	01	INCO, Copper Cliff T.P. - Final Discharge	75
	02	INCO, Crean Hill Mine - Minewater	8
	04	INCO, Garson Mine - Minewater	42
	07	INCO, Levack Mine - Minewater	58
	10	INCO, Refinery, Sudbury - Discharge from second pond	83
	11	INCO, Nolin Creek T.P. - Final discharge	83
	15	Falconbridge, Strathcona - Final discharge	8
	16	INCO, Whistle Mine - Minewater discharge	67
	19	Dickenson, Arthur W. White Mine - Final discharge	73
	39	Giant Yellowknife, Pamour #1 - Decant weir #2	9
COPPER (0.3 ppm)	01	INCO, Copper Cliff T.P. - Final Discharge	8
	05	Noranda Minerals, Geco Division - WWTP effluent	8
	09	Falconbridge, Metallurgical - Final discharge	25
	11	INCO, Nolin Creek T.P. - Final discharge	33
	13	INCO, Refinery, Port Colbourne - Final discharge	8
	19	Dickenson, Arthur W. White Mine - Final discharge	100
	21	Canamax, Bell Creek Mine - Final discharge	33
	25	Placer Dome, Detour Lake Mine - Final discharge	67
	26	Placer Dome, Dome Mine - Final discharge	33
	29	Giant Yellowknife, ERG Resources - Final discharge	50
	32	LAC Minerals, Macassa Division - Final discharge	25
	39	Giant Yellowknife, Pamour #1 - Decant weir #2	9
	42	Renabie Gold Mines - Final discharge	57
ZINC (0.5 ppm)	06	Falconbridge, Kidd Creek Mine - Minewater	67
	09	Falconbridge, Metallurgical - Final discharge	58
	17	Minnova, Winston Lake Mine - Final discharge	33
	21	Canamax, Bell Creek Mine - Final discharge	33
	42	Renabie Gold Mines - Final discharge	100

TABLE 5. SITES REPORTING LEVELS ABOVE REFERENCE FOR SELECTED PARAMETERS (CONT.)

PARAMETER (reference level)	Site No.	METAL PRODUCER	Percent of Samples over Reference lev.
AMMONIA (10 ppm)	05	Noranda Minerals, Geco Division - WWTP effluent	100
	12	Falconbridge, Onaping - Discharge from Onaping mine pond	100
	24	Teck-Corona, David Bell Mine - Final discharge	91
	25	Placer Dome, Detour Lake Mine - Final discharge	42
	29	Giant Yellowknife, ERG Res. - Final discharge	100
	30	Hemlo Gold Mines, Golden Giant - Final discharge	100
	31	Canamax, Kremzar Mine - Effluent from SE clear water	33
	32	LAC Minerals, Macassa Division - Final discharge	8
	35	Canamax, Marhill Mine - Minewater	8
	38	LAC Minerals, Williams Mine - Minewater	100
	38	LAC Minerals, Williams Mine - Final discharge	100
	51	Denison Mines, Denison Property - Final discharge (PR 0100)	100
	51	Denison Mines, Denison Property - Final discharge (SW 0200)	8
	53	Rio Algom, Panel - Final discharge	58
	55	Rio Algom, Quirke - Final discharge	100
PHENOLICS (20 ppb)	01	INCO, Copper Cliff T.P. - Final discharge	8
	03	Falconbridge, Falconbridge - Final discharge	8
	08	Falconbridge, Lockerby - Minewater	8
	10	INCO, Refinery, Sudbury - discharge from second pond	50
	12	Falconbridge, Onaping - Discharge from Onaping mine pond	27
	14	INCO, Shebandowan Mine - Final discharge	17
	19	Dickenson, Arthur W. White Mine - Final discharge	55
	28	Eastmaque Gold Mines - Final discharge	18
	32	LAC Minerals, Macassa Division - Final discharge	17
	36	American Barrick, McDermott - Final discharge	33
	39	Giant Yellowknife, Pamour #1 - Decant weir #2	100
	56	Cameco, Refinery, Blind River - Final discharge	11
OIL/GREASE (15 ppm)	35	Canamax, Marhill Mine - Minewater	8
	56	Cameco, Refinery, Blind River - Final discharge	100

TABLE 5. SITES REPORTING LEVELS ABOVE REFERENCE FOR SELECTED PARAMETERS (CONT.)

PARAMETER (reference level)	Site No.	METAL PRODUCER	Percent of Samples over Reference lev.
T.S.S. (15 ppm)	01	INCO, Copper Cliff T.P. - Final discharge	75
	05	Noranda Minerals, Geco Division - WWTP effluent	25
	06	Falconbridge, Kidd Creek Mine - Minewater	8
	07	INCO, Levack Mine - Minewater	42
	09	Falconbridge, Metallurgical - Final discharge	42
	11	INCO, Nolin Creek T.P. - Final discharge	50
	16	INCO, Whistle Mine - Minewater discharge	22
	17	Minnova, Winston Lake Mine - Final discharge	33
	21	Canamax, Bell Creek Mine - Final discharge	20
	28	Eastmaque Gold Mines - Final discharge	17
	30	Hemlo Gold Mines, Golden Giant - Final discharge	29
	32	LAC Minerals, Macassa Division - Final discharge	8
	35	Canamax, Marhill Mine - Minewater	100
	38	LAC Minerals Ltd. Williams Mine, Hemlo	100
	39	Giant Yellowknife, Pamour #1 - Decant weir #2	36
	39	Giant Yellowknife, Pamour #1 - Decant weir #1A	67
	45	St. Andrews Gold Fields - Process effluent	60
	46	Algoma Steel, Ore division - Final decant	17
	51	Denison Mines, Denison Property - Final discharge	8
	56	Cameco, Refinery, Blind River - Final discharge	100
	57	Cameco, Refinery, Port Hope - West UF6/NUO2 Combined effl.	44
	57	Cameco, Refinery, Port Hope - East UF6 discharge	22
	57	Cameco, Refinery, Port Hope - UO2 discharge	33
ARSENIC (0.5 ppm)	19	Dickenson, Arthur W. White Mine - Final discharge	100
	21	Canamax, Bell Creek Mine - Final discharge	33
MOLYBDENUM (0.5 ppm)	28	Eastmaque Gold Mines - Final discharge	75
	30	Hemlo Gold Mines, Golden Giant - Final discharge	50
	32	LAC Minerals, Macassa Division - Final discharge	67

TABLE 5. SITES REPORTING LEVELS ABOVE REFERENCE FOR SELECTED PARAMETERS (CONT.)

PARAMETER (reference level)	Site No.	METAL PRODUCER	Percent of Samples over Reference lev.
CYANIDE (total) (1 ppm)	09	Falconbridge, Metallurgical - Final discharge	42
	32	LAC Minerals, Macassa Division - Final discharge	25
	39	Giant Yellowknife, Pamour #1 - Decant weir #2	9
	42	Renabie Gold Mines - Final discharge	44
	56	Carneco, Refinery, Blind River - Final discharge	50
pH (6-9.5)	01	INCO, Copper Cliff T.P. - Final discharge	100
	02	INCO, Crean Hill Mine - Minewater	58
	04	INCO, Garson Mine - Minewater	92
	05	Noranda Minerals, Geco Division - WWTP effluent	17
	06	Falconbridge, Kidd Creek Mine - Minewater	100
	07	INCO, Levack Mine - Minewater	50
	09	Falconbridge, Metallurgical - Final discharge	100
	10	INCO, Refinery - Discharge from second pond	100
	11	INCO, Nolin Creek T.P. - Final discharge	83
	12	Falconbridge, Onaping - Discharge from Onaping mine pond	83
	13	INCO, Refinery, Port Colbourne - Final discharge	100
	15	Falconbridge, Strathcona - Final discharge	8
	16	INCO, Whistle Mine - Minewater discharge	22
	38	LAC Minerals, Williams Mine - Minewater	50
	46	Algoma Steel, Ore Division - Final decant	50
	54	Rio Algom, Pronto - Final discharge	17
MERCURY (1 ppb)	24	Teck-Corona, David Bell Mine - Final discharge	11
	27	Placer Dome, Dona Lake Mine - Final discharge	80
	30	Hemlo Gold Mines, Golden Giant - Final discharge	20
	36	American Barrick, McDermott - Final discharge	33
	38	LAC Minerals, Williams Mine - Minewater	50
	42	Renabie Gold Mines - Final discharge	20
	46	Algoma Steel, Ore Division - Final decant	17
	56	Cameco, Refinery, Blind River - Final discharge	25

TABLE 6. OVERALL RESULTS OF BIOTOXICITY TESTS

Property (solution)	Acute Lethality Tests Overall Results	Suspected Causes
<u>BASE METAL PRODUCERS</u>		
Copper Cliff (treatment plant)	Lethal to trout	Cu, pH
Geco Division (final discharge)	Lethal to trout & daphnia	Cu, NH ₃
Kidd Creek (minewater)	Lethal to trout & daphnia	Cu, pH, Zn
Levack site (minewater)	Lethal to trout	Cu, pH, Ni
Onaping Mine (mine pond)	Lethal to trout & daphnia	pH, NH ₃
Port Colborne (final discharge)	Lethal to trout & daphnia	Cu, pH
Whistle Mine (minewater)	Lethal to daphnia	pH
Inco Nickel Refinery	Lethal to daphnia on dilution	Undetermined
Falconbridge Nickel Refinery	Lethal to daphnia on dilution	Undetermined
<u>GOLD PRODUCERS</u>		
Arthur W. White (final discharge)	Lethal to daphnia	Cu, As
Renabie Gold Mines (final discharge)	Lethal to trout & daphnia	Cu, Zn, CN
Detour Lake Mine (final discharge)	Lethal to trout & daphnia	Cu, CN
Dome Mine (final discharge)	Lethal to daphnia	Cu
<u>IRON PRODUCERS</u>		
Algoma Ore Division	Non-lethal	
<u>URANIUM PRODUCERS</u>		
Denison Property (Elliott Lake)	Generally non-lethal	
Quirke	Sometimes lethal to either animal	
Blind River (refinery discharge)	Lethal to trout & daphnia	Oil/grease
Port Hope	Non-lethal	
Stanleigh site, Rio Algom	Non-lethal	
Stanrock, Denison	Non-lethal	